Josephson Arrays in a Resonant Cavity
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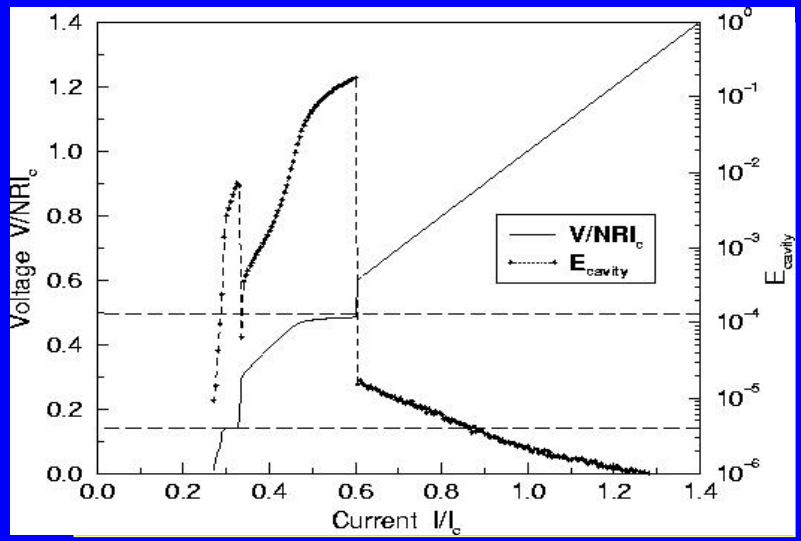
Josephson junctions are unique electronic devices which can convert a direct current into an alternating voltage.

When a collection of such junctions is combined into an array, the junctions can all oscillate coherently, radiating a lot of energy. But it is difficult to cause this coherence to occur.

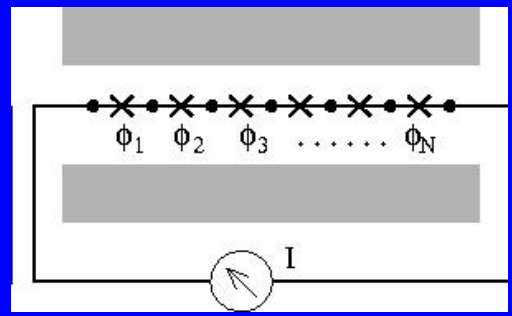
Recently, experiments have shown that coherence can be achieved by placing the array in a microwave cavity.

We have now developed a theory for this coupled system, which reproduces most of the experimental features.

We see two crucial features of the experiment in this picture: Self-Induced Resonant Steps (SIRS's) (flat regions in the curves at multiples of the resonant frequency); and (ii) a lot of energy radiated into the cavity. This opens up a possible new coherent source of microwaves.



Current-voltage characteristics of series array (V/NRI_c). Also shown is total energy in cavity vs. current.



Geometry of current-driven series array in microcavity

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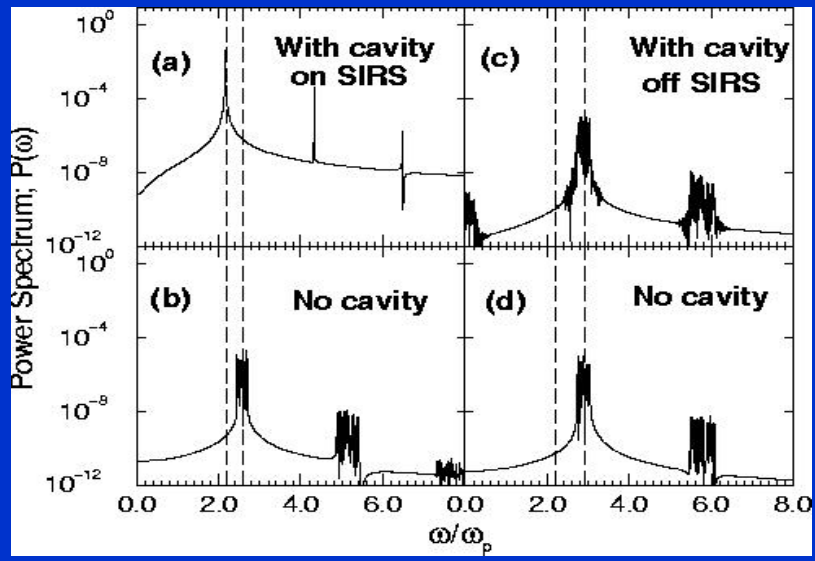
To illustrate the predicted coherence, we show at right the power spectrum emitted from the array.

When the array is contained in a cavity and is tuned on SIRS, there is a very large coherent emission into the cavity. If there is no cavity, or the array is tuned off the step, there is no coherent emission, and much less power is radiated into the array.

The individual junctions behave very much like single atoms, and the array as a whole exhibits behavior similar to a laser.

We are presently investigating whether the same behavior might be seen in BSCCO and other high-temperature superconductors, which behave like stacks of many Josephson junctions.



Educational Activities:
Project participants: Four graduate students (Eivind Almaas, Sergey Barabash, W. A. Al-Saidi, Ivan Tornes),
One postdoctoral researcher (Sung Yong Park).
International Collaborator: David J. Bergman (Tel –Aviv University)